PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-070663

(43)Date of publication of application : 08.03.2002

(51)Int.Cl. F02M 31/07
B60H 1/03
F02M 31/08
F24H 1/12

(21)Application number : 2000-257736

(22)Date of filing : 28.08.2000

(71)Applicant : TOYOTA MOTOR CORP

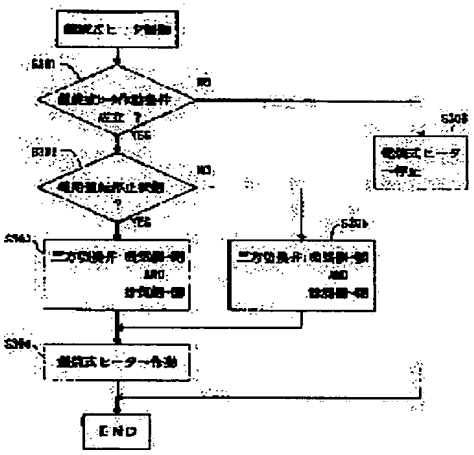
(72)Inventor : SUZUKI MAKOTO

(54) INTERNAL COMBUSTION ENGINE HAVING COMBUSTION HEATER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a technique for preventing a liquid such as condensed water from staying in an intake passage before the start of an internal combustion engine in the internal combustion engine having a combustion heater.

SOLUTION: This internal combustion engine having the combustion heater is characterized by comprising the combustion heater having a combustion chamber independent of the internal combustion engine, a first passage for guiding a combustion gas of the combustion heater or a medium heated by the combustion heater to the intake passage of the internal combustion engine, a second passage for guiding the combustion gas of the combustion heater or the medium heated by the combustion heater to an exhaust passage of the internal combustion engine, and a passage switching means for closing the first passage and opening the second passage when the internal combustion engine is in an operation stop state during the operation of the combustion heater.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The 1st path which leads the medium heated by the combustion heater which has the combustion chamber which became independent of an internal combustion engine, and the combustion gas of said combustion heater or said combustion heater to said internal combustion engine's inhalation-of-air path, The 2nd path which leads the medium heated by the combustion gas of said combustion heater, or said combustion heater to said internal combustion engine's flueway, The internal combustion engine which has the combustion heater characterized by having the path means for switching which makes lock out and the 2nd path open said 1st path wide when an internal combustion engine is in a shutdown condition at the time of actuation of said combustion heater.
[Claim 2] Said path means for switching is an internal combustion engine which has the combustion heater according to claim 1 characterized by blockading disconnection and the 2nd path for said 1st path after it makes lock out and the 2nd path open wide and said internal combustion engine puts said 1st path into operation until said internal combustion engine started, when the actuation demand of said combustion heater occurs before said internal combustion engine starts between the colds.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the internal combustion engine which has the combustion heater which heats an internal combustion engine, the air for heating, etc. through a predetermined medium especially about the internal combustion engine carried in a car etc.
[0002]
[Description of the Prior Art] In recent years, in the internal combustion engine carried in an automobile etc., especially the internal combustion engine whose calorific value tends [comparatively] to decrease like a compression ignition-type Diesel engine, the technique in which a combustion heater is put side by side for the purpose of improvement in the engine performance of the heating apparatus for the interior of a room, an internal combustion engine's warming-up promotion, etc. at the time between the engine colds is proposed.
[0003] The thing equipped with the heat exchange section which consists of a heat carrier path formed so that the combustion chamber which became independent of an internal combustion engine, and its combustion chamber might be surrounded as a combustion heater which was described above, for example, the inhalation-of-air installation path for supplying a combustion air to a combustion chamber, and the fuel-supply path which supplies some fuels for an internal combustion engine to a combustion chamber is known.
[0004] Thus, in the constituted combustion heater, engine cooling water and the air for heating can be used as a heat carrier.
[0005] When engine cooling water is used as a heat carrier, while becoming possible to promote an internal combustion engine's warming up by supplying the cooling water heated with the combustion heater at the time between [of an internal combustion engine] the colds etc. to an internal combustion engine's water jacket, it becomes possible to raise the heating engine performance by supplying the cooling water heated with the combustion heater to the heater core of the heating apparatus for the interior of a room.
[0006] Moreover, by supplying the air for heating heated with the combustion heater to the vehicle interior of a room, when the air for heating is used as a heat carrier, even if it is a time of an internal combustion engine being in the condition between the colds, it becomes possible to raise the heating engine performance.
[0007] Furthermore, when an internal combustion engine starts between the colds, raising an internal combustion engine's intake-air temperature, with raising an internal combustion engine's startability is also considered by supplying the air for heating heated by the hot combustion gas or the hot combustion heater discharged from the combustion heater to an internal combustion engine's inhalation-of-air path.
[0008] For example, the inhalation-of-air superheater equipment of the internal combustion engine of the car indicated by JP,60-79149,A It is constituted so that the air for heating heated by the combustion heater can be alternatively supplied to either or the both sides of the heating apparatus for vehicle rooms, and an internal combustion engine's inlet pipe. By supplying the air for heating heated by the combustion heater to an internal combustion engine's inhalation-of-air path, at the time an internal combustion engine's starting and between the colds etc., an internal combustion engine's intake-air temperature tends to be raised, with it tends to aim at improvement in startability and warming-up nature.
[0009]
[Problem(s) to be Solved by the Invention] By the way, when carrying out the temperature up of an internal combustion engine's inhalation of air using the air for heating heated by combustion gas and the combustion heater of the elevated temperature discharged from a combustion heater and an internal combustion engine

is in a shutdown condition, when hot combustion gas or the air for heating is supplied in a low-temperature inhalation-of-air path, gases, such as a steam in combustion gas or the air for heating, liquefy, it becomes the water of condensation, and there is a possibility that the water of condensation may pile up in an inhalation-of-air path.

[0010] This invention is made in view of a trouble which was described above, and aims at offering the technique of preventing liquids, such as the water of condensation, piling up in an inhalation-of-air path before an internal combustion engine's starting in the internal combustion engine which has a combustion heater.

[0011]

[Means for Solving the Problem] The following means were used for this invention in order to solve a technical problem which was described above.

[0012] Namely, the internal combustion engine which has a combustion heater concerning this invention The 1st path which leads the medium heated by the combustion heater which has the combustion chamber which became independent of an internal combustion engine, and the combustion gas of said combustion heater or said combustion heater to said internal combustion engine's inhalation-of-air path, The 2nd path which leads the medium heated by the combustion gas of said combustion heater, or said combustion heater to said internal combustion engine's flueway, If an internal combustion engine is in a shutdown condition at the time of actuation of said combustion heater, it is characterized by having the path means for switching which makes lock out and the 2nd path open said 1st path wide.

[0013] thus, in the internal combustion engine having the constituted combustion heater, when a combustion heater operates and an internal combustion engine is in a shutdown condition, the 1st path is blockaded -- the 2nd path is opened [both] wide.

[0014] In this case, the medium heated by the combustion gas of a combustion heater or the combustion heater will circulate the 2nd path, and will be led to an internal combustion engine's flueway. Consequently, when operation of an internal combustion engine is suspended, in an inhalation-of-air path, gases, such as a steam which hot combustion gas or a hot medium does not flow into a low-temperature inhalation-of-air path, and is contained in combustion gas or a medium, liquefy, and do not pile up.

[0015] Moreover, when a combustion heater operates and an internal combustion engine is in a shutdown condition, the case where the air for a preheating or the heating for the interior of a room needs to be heated for an internal combustion engine at the time between [of an internal combustion engine] the colds etc. can be illustrated [******]. In that case, after it opens lock out and said 2nd path wide and an internal combustion engine puts said 1st path into operation until the internal combustion engine started, as for a path means for switching, it is desirable to make it blockade disconnection and said 2nd path for said 1st path.

[0016]

[Embodiment of the Invention] The concrete embodiment of the internal combustion engine which has a combustion heater concerning this invention hereafter is explained based on a drawing.

[0017] Drawing 1 is drawing showing one embodiment of the internal combustion engine which has a combustion heater.

[0018] The internal combustion engine 1 which shows drawing 1 is the injection mold diesel power plant in a cylinder of the water cooling type equipped with the fuel injection valve which injects a direct fuel to the combustion chamber of each gas column while having two or more gas columns.

[0019] The inhalation-of-air branch pipe 2 is connected to an internal combustion engine 1, and each branch pipe of the inhalation-of-air branch pipe 2 is open for free passage through the combustion chamber of each gas column, and the suction port which is not illustrated. Said inhalation-of-air branch pipe 2 is connected to an inlet pipe 3, and the inlet pipe 3 is connected to the air cleaner box 4 which carried out the interior of the air filter.

[0020] In the middle of the inlet pipe 3, compressor housing 5a of a centrifugal supercharger (turbocharger) 5 is prepared. In compressor housing 5a, the compressor wheel which is not illustrated is supported free [rotation]. The revolving shaft of this compressor wheel is connected with the revolving shaft of the turbine wheel supported free [rotation in turbine housing 5b mentioned later], and a compressor wheel and a turbine wheel rotate it by one.

[0021] Then, when compressed into the inlet pipe 3 of said compressor housing 5a lower stream of a river in said compressor housing 5a, the intercooler 6 which cools the inhalation of air used as an elevated temperature is formed. The inhalation-of-air throttle valve 7 which adjusts the inhalation-of-air flow rate in an inlet pipe 3 is formed in the inlet pipe 3 of said intercooler 6 lower stream of a river, and the actuator 8

which carries out the closing motion drive of this inhalation-of-air throttle valve 7 is attached in this inhalation-of-air throttle valve 7.

[0022] Thus, by the constituted inhalation-of-air system, after the new mind which flowed into the air cleaner box 4 is removed by the air filter in dust or dust, it is led to compressor housing 5a through an inlet pipe 3, and is compressed within compressor housing 5a. The new mind which was compressed within compressor housing 5a and became an elevated temperature is cooled by the intercooler 6. After the inhalation of air cooled by the intercooler 6 has a flow rate adjusted by the inhalation-of-air throttle valve 7 if needed, it is distributed to the combustion chamber of each gas column through the inhalation-of-air branch pipe 2, and burns considering the fuel injected from the fuel injection valve which is not illustrated as an ignition source.

[0023] On the other hand, the exhaust air branch pipe 9 is connected to an internal combustion engine 1, and each branch pipe of this exhaust air branch pipe 9 is open for free passage through the combustion chamber of each gas column, and the exhaust air port which is not illustrated. Said exhaust air branch pipe 9 is connected to an exhaust pipe 10, and the exhaust pipe 10 is connected to the muffler which is not illustrated on a lower stream of a river.

[0024] In the middle of said exhaust pipe 10, the exhaust air purification catalyst 11 which purifies the harmful gas component under exhaust air is arranged. As this exhaust air purification catalyst 11, the particulate filter which supported the selection reduction type Lean NOX catalyst, the occlusion reduction type Lean NOX catalyst, or the oxidation catalyst can be illustrated.

[0025] Turbine housing 5b which carried out the interior of the turbine wheel which rotates with the pressure of exhaust air to the exhaust pipe 10 of said exhaust air purification catalyst 11 upstream is arranged. The exhaust-gas-recirculation path (EGR path) 12 which leads a part of exhaust air which flows the inside of an exhaust pipe 10 to the inlet pipe 3 (or inhalation-of-air branch pipe 2) of said inhalation-of-air throttle valve 7 lower stream of a river is connected to the exhaust pipe 10 (or exhaust air branch pipe 9) of said turbine housing 5b upstream, and while being the EGR path 12, the EGR valve 13 which adjusts the amount of recycling of exhaust air is formed.

[0026] Thus, by the constituted exhaust air system, the gaseous mixture which burned in the combustion chamber of each gas column is led to an exhaust pipe 10 through each branch pipe of the exhaust air branch pipe 9, and, subsequently to in turbine housing 5b, flows. After the exhaust air which flowed in turbine housing 5b rotates a turbine wheel, it is discharged from turbine housing 5b, and it flows into the exhaust air purification catalyst 11 through the exhaust pipe 10 of a turbine housing 5b lower stream of a river. If the catalyst floor temperature of the exhaust air purification catalyst 11 is beyond activity temperature in that case, in the exhaust air purification catalyst 11, the harmful gas component under exhaust air will be purified.

[0027] Moreover, when the EGR valve 13 is in a valve-opening condition, a part of exhaust air which flows an exhaust pipe 10 is led to an inlet pipe 3 through the EGR path 12, and being mixed with new mind of having flowed from the upstream of an inlet pipe 3, it is led to an internal combustion engine's 1 combustion chamber, and afterburns considering the fuel injected from the fuel injection valve which is not illustrated as an ignition source.

[0028] Next, the combustion heater 14 is put side by side to the internal combustion engine 1. As a combustion heater 14 is shown in drawing 2 , it has the combustion cylinder 142 by which an internal combustion engine 1 burns independently the fuel for internal combustion engine 1 by carrying out interior to an outer case 140, the middle cylinder 141 by which interior is carried out to an outer case 140, and the middle cylinder 141.

[0029] Said combustion cylinder 142 possesses the evaporation glow plug (not shown) for evaporating a fuel, and the ignition glowing plug (not shown) for lighting the fuel evaporated by said evaporation glow plug. In addition, an evaporation glow plug and an ignition glowing plug may be made to be made to serve a double purpose with a single glow plug.

[0030] Then, between said outer cases 140 and said middle cylinders 141, the cooling water way 200 in a heater for pouring an internal combustion engine's 1 cooling water is formed. The cooling water installation port 143 for taking in cooling water and the cooling water discharge port 144 for discharging the cooling water in said cooling water way 200 in a heater are formed in said cooling water way 200 in a heater at said outer case 140.

[0031] As shown in drawing 1 , said cooling water installation port 143 is open for free passage through the engine water jacket and the cooling water installation tubing 22 which an internal combustion engine 1 does not illustrate, and is opening said cooling water discharge port 144 for free passage through said engine

water jacket and cooling water exhaust pipe 23.
[0032] Electromotive Water pump 24 is formed in the middle of said cooling water installation tubing 22, and the cooling water which flows the inside of an internal combustion engine's 1 engine water jacket is compulsorily sent into said cooling water installation port 143.
[0033] In the middle of said cooling water exhaust pipe 23, the heater core 25 of the heating apparatus for the interior of a room is arranged, and the heat in which the flowing cooling water has said cooling water exhaust pipe 23 is transmitted to the air for heating.
[0034] Next, between said middle cylinders 141 and combustion cylinders 142, the combustion gas path 201 for passing the combustion gas which occurred by said combustion cylinder 142 is formed. The combustion gas discharge port 145 which opens said combustion gas path 201 and exterior of said outer case 140 for free passage is formed in the suitable part of said middle cylinder 141.
[0035] Said combustion gas discharge port 145 is open for free passage to the Mikata change-over valve 17 through the combustion gas discharge path 16, as shown in drawing 1 . In addition to the 1st above-mentioned combustion gas discharge path 16, the inspired air flow path discharge path 18 and the exhaust side discharge path 19 are connected to said Mikata change-over valve 17.
[0036] the exhaust pipe 10 with which said inspired air flow path discharge path 18 is connected to the inlet pipe 3 of said inhalation-of-air throttle valve 7 upstream, and said exhaust side discharge path 19 is located between said exhaust air purification catalyst 11 and said turbine housing 5b -- it connects with the said about 11 exhaust air purification catalyst exhaust pipe 10 preferably.
[0037] Said Mikata change-over valve 17 switches a flow (said exhaust side discharge path 19 lock out) of said 1st combustion gas discharge path 16 and said inspired air flow path discharge path 18 and a flow (said inspired air flow path discharge path 18 lock out) of said 1st combustion gas discharge path 16 and said exhaust side discharge path 19 by blockading alternatively either of said inspired air flow path discharge path 18 and said exhaust side discharge path 19.
[0038] Next, the fuel installation tubing 27 is connected to the combustion cylinder 142. As this fuel installation tubing 27 is shown in drawing 1 , it connects with a fuel pump 26 and the fuel breathed out from said fuel pump 26 is supplied to said combustion cylinder 142 through said fuel installation tubing 27.
[0039] On the other hand, the housing 148 which carried out the interior of the blower fan 149 for sending the air for combustion into said combustion cylinder 142 and the motor 150 which carries out the rotation drive of this blower fan 149 is attached in said outer case 140.
[0040] The suction port 151 for incorporating a combustion air is formed in this housing 148 at said housing 148. As shown in drawing 1 , the inhalation-of-air installation path 15 is connected to said suction port 151, and in said inlet pipe 3, from the connection part with said inspired air flow path discharge path 18, said inhalation-of-air installation path 15 is the upstream, and is connected to the part located down-stream by compressor housing 5a.
[0041] Thus, in the constituted combustion heater 14, when the preheating of internal combustion engine 1 body, warming-up promotion, the improvement in the engine performance of the heating apparatus for the interior of a room, or the temperature up of the exhaust air purification catalyst 11 needs to be planned, it operates, for example.
[0042] With a combustion heater 14, a part of inhalation of air to which a motor 150 operates a blower fan 149 and flows the inside of an inlet pipe 3 is supplied to the combustion cylinder 142 of a combustion heater 14, the fuel in the fuel tank which a fuel pump 26 does not illustrate is sucked up, the combustion cylinder 142 of a combustion heater 14 is supplied, Water pump 24 operates further, and, specifically, the cooling water in an internal combustion engine's 1 engine water jacket is fed to the cooling water installation port 143 of a combustion heater 14.
[0043] And the glow plug of the combustion cylinder 142 energizes and the gaseous mixture of the inhalation of air supplied with said blower fan 149 and the fuel supplied by said fuel pump 26 burns within the combustion cylinder 145.
[0044] The combustion gas which burned within said combustion cylinder 145 is extruded by the pressure of the inhalation of air sent out with a blower fan 149 from the inside of the combustion cylinder 145 at the combustion gas path 201, and, subsequently is discharged from the combustion gas path 201 in the combustion gas discharge port 145.
[0045] The combustion gas discharged in the combustion gas discharge port 145 reaches the Mikata change-over valve 17 through the combustion gas discharge path 16, and is led to the inspired air flow path discharge path 18 or the exhaust side discharge path 19 by the Mikata change-over valve 17.
[0046] On the other hand, after leading the cooling water fed in the cooling water installation port 143 of a

combustion heater 14 from said cooling water installation port 143 to the cooling water way 200 in a heater and passing along the cooling water way 200 in a heater with Water pump 24, it is discharged in the cooling water discharge port 144.
[0047] In that case, it is transmitted to the cooling water with which the heat of the combustion gas which flows the combustion gas path 201 flows the inside of the cooling water way 200 in a heater through the wall surface of the middle cylinder 144, and the temperature of cooling water rises. Thus, the cooling water way 200 in a heater and the combustion gas path 201 realize the heat exchange section.
[0048] Thus, the cooling water by which the temperature up was carried out is discharged from the cooling water discharge port 144 to the cooling water exhaust pipe 23, is returned into an internal combustion engine's 1 engine water jacket through the heater core 25, and circulates through the inside of an engine water jacket. With the heater core 25, a part of heat which cooling water has is transmitted to the air for heating, and the temperature up of the air for heating is carried out.
[0049] The electronic control unit 28 for engine control (ECU:Electronic Control Unit) is put side by side to return and an internal combustion engine 1 here at drawing 1 . ECU28 consists of CPU, ROMs, RAM, input interface circuitries, output interface circuitries, etc. which were mutually connected by the bidirectional bus. And various kinds of sensors are connected to said input interface circuitry through electric wiring, and the EGR valve 13, an actuator 8, the combustion heater 14 (the motor 150 of a blower fan 149, glow plug of the combustion cylinder 142), the Mikata change-over valve 17, Water pump 24, and the fuel pump 26 grade are connected to said output interface circuitry through electric wiring.
[0050] As a sensor connected to said input interface circuitry A sensor 32, the accelerator pedal which is not illustrated, or an accelerator pedal is interlocked with whenever [catalyst temperature / which was attached in the air flow meter 29 attached in the inlet pipe 3, the crank position sensor 30 attached in the internal combustion engine 1 and the coolant temperature sensor 31, and the exhaust air purification catalyst 11]. The accelerator position sensor 33 attached in the accelerator lever which operates, an ignition switch (IG.SW) 34, and starting-switch (ST.SW) 35 grade can be illustrated.
[0051] Said air flow meter 29 is a sensor which outputs the electrical signal corresponding to the mass of the inhalation of air which flows the inside of an inlet pipe 3. Said crank position sensor 30 is a sensor which outputs a pulse signal, whenever the crankshaft which an internal combustion engine 1 does not illustrate carries out predetermined include-angle rotation. Said coolant temperature sensor 31 is a sensor which outputs the electrical signal corresponding to the temperature of the cooling water which flows an internal combustion engine's 1 engine water jacket. A sensor 32 is a sensor which outputs the electrical signal corresponding to the catalyst floor temperature of the exhaust air purification catalyst 11 whenever [catalyst temperature]. The accelerator position sensor 33 is a sensor which outputs the electrical signal corresponding to the control input of an accelerator pedal.
[0052] ECU28 performs combustion heater control used as the summary of this invention while it judges an internal combustion engine's 1 operational status based on the output signal value of various sensors which were described above and performs fuel-injection control etc. based on the judgment result.
[0053] Hereafter, the combustion heater control performed by ECU28 is described.
[0054] ECU28 performs a combustion heater control routine as shown in drawing 3 at the time of operation of an internal combustion engine 1. This combustion heater control routine is a routine repeatedly performed for every (for example, whenever [to which the crank position sensor 30 outputs a pulse signal]) predetermined time.
[0055] In said combustion heater control routine, ECU28 distinguishes whether the actuation conditions of a combustion heater 14 are first satisfied in S301. As actuation conditions for the combustion heater 14 here For example, the output signal value (catalyst floor temperature of the exhaust air purification catalyst 11) of a sensor 32 is under activity temperature whenever [catalyst temperature]. It is the NOX reduction processing activation stage to be the SOx poisoning recovery activation stage of the exhaust air purification catalyst 11 in case the exhaust air purification catalyst 11 is an occlusion reduction type NOX catalyst. It can illustrate that the output signal value (circulating water temperature) of a coolant temperature sensor 31 which has a heating apparatus for the interior of a room in an operating state is under predetermined temperature (that is, an internal combustion engine 1 is in the condition between the colds) etc.
[0056] When it judges with combustion heater actuation conditions being satisfied in said S301, ECU28 progresses to S302 and distinguishes whether an internal combustion engine 1 is in a shutdown condition.
[0057] When judged with an internal combustion engine 1 being in a shutdown condition in said S302, it controls the Mikata change-over valve 17 so that ECU28 may progress to S303, and may blockade the inspired air flow path discharge path 18 and may open the exhaust side discharge path 19 wide, and makes it

flow through the combustion gas discharge path 16 and the exhaust side discharge path 19.
[0058] Then, in S304, ECU28 impresses drive power to the glow plug of a motor 150, a fuel pump 26, and the combustion cylinder 142, and operates a combustion heater 14.
[0059] In this case, as for the combustion gas discharged from the combustion heater 14, the combustion gas discharge path 16 -> Mikata change-over valve 17 -> exhaust side discharge path 19 will be led to a connoisseur from the exhaust air purification catalyst 11 one by one to the upstream exhaust pipe 10.
[0060] Consequently, when an internal combustion engine 1 is in a shutdown condition, within an inlet pipe 3, gases, such as a steam which the hot combustion gas discharged from the combustion heater 14 is not supplied into the low-temperature inlet pipe 3, and is contained in combustion gas, liquefy, and do not pile up.
[0061] Moreover, when judged with an internal combustion engine 1 being already in operational status in said S302, ECU28 opens the inspired air flow path discharge path 18 wide, and controls the Mikata change-over valve 17 that the exhaust side discharge path 19 should be blockaded, and makes it flow through the combustion gas discharge path 16 and the inspired air flow path discharge path 18.
[0062] Then, in S304, ECU28 impresses drive power to the glow plug of a motor 150, a fuel pump 26, and the combustion cylinder 142, and operates a combustion heater 14.
[0063] In this case, as for the combustion gas discharged from the combustion heater 14, the combustion gas discharge path 16 -> Mikata change-over valve 17 -> inspired air flow path discharge path 18 will be led to a connoisseur one by one to an inlet pipe 3.
[0064] Consequently, since the hot combustion gas discharged from the combustion heater 14 is supplied into an inlet pipe 3 when an internal combustion engine 1 is in operational status, the temperature of inhalation of air, the temperature of gaseous mixture, and the compression edge temperature of a combustion chamber are raised by the heat which combustion gas has, with an internal combustion engine's 1 ignitionability and combustion stability improve.
[0065] On the other hand, when judged with the actuation conditions of a combustion heater 14 being abortive in the above mentioned S301, ECU28 stops the drive power application to the glow plug of a motor 150, a fuel pump 26, and the combustion cylinder 142, and stops actuation of a combustion heater 14.
[0066] Thus, when ECU28 performs a combustion heater control routine, the path means for switching concerning this invention will be realized.
[0067] Therefore, since the combustion gas discharged from the combustion heater 14 will be led to an exhaust pipe 10 when according to the internal combustion engine which has a combustion heater concerning the gestalt of this operation the actuation demand of a combustion heater 14 occurs before an internal combustion engine 1 starts between the colds, it is lost that the hot combustion gas discharged from the combustion heater 14 flows into the low-temperature inlet pipe 3.
[0068] Consequently, when hot combustion gas flows in in the low-temperature inlet pipe 3, the steam in combustion gas serving as the water of condensation, and piling up in an inlet pipe 3 is lost.
[0069] In addition, although the combustion heater through engine cooling water was mentioned as the example and the gestalt of this operation explained it, you may be the combustion heater which carries out the medium of the gases, such as air for heating. Moreover, although the gestalt of this operation described the example which discharges the combustion gas of a combustion heater alternatively to either of an internal combustion engine's inhalation-of-air path and a flueway, you may be the combustion heater which can supply gases, such as air for heating, to either of an internal combustion engine's inhalation-of-air path and a flueway alternatively, and when an internal combustion engine is in a shutdown condition in that case, the gas heated by the combustion heater should just be supplied to a flueway.
[0070]
[Effect of the Invention] In the internal combustion engine which has a combustion heater concerning this invention, if an internal combustion engine is in a shutdown condition when a combustion heater operates, since the 1st path will be blockaded and the 2nd path will be opened wide, when the medium heated by the combustion gas of a combustion heater or the combustion heater will be led to an internal combustion engine's flueway and operation of an internal combustion engine is suspended, hot combustion gas or a hot medium does not flow into a low-temperature inhalation-of-air path.
[0071] Therefore, according to the internal combustion engine which has a combustion heater concerning this invention, it becomes possible to prevent gases, such as a steam contained in the combustion gas or the medium of a combustion heater, serving as the water of condensation in an inhalation-of-air path, and piling up at the time of an internal combustion engine's shutdown.

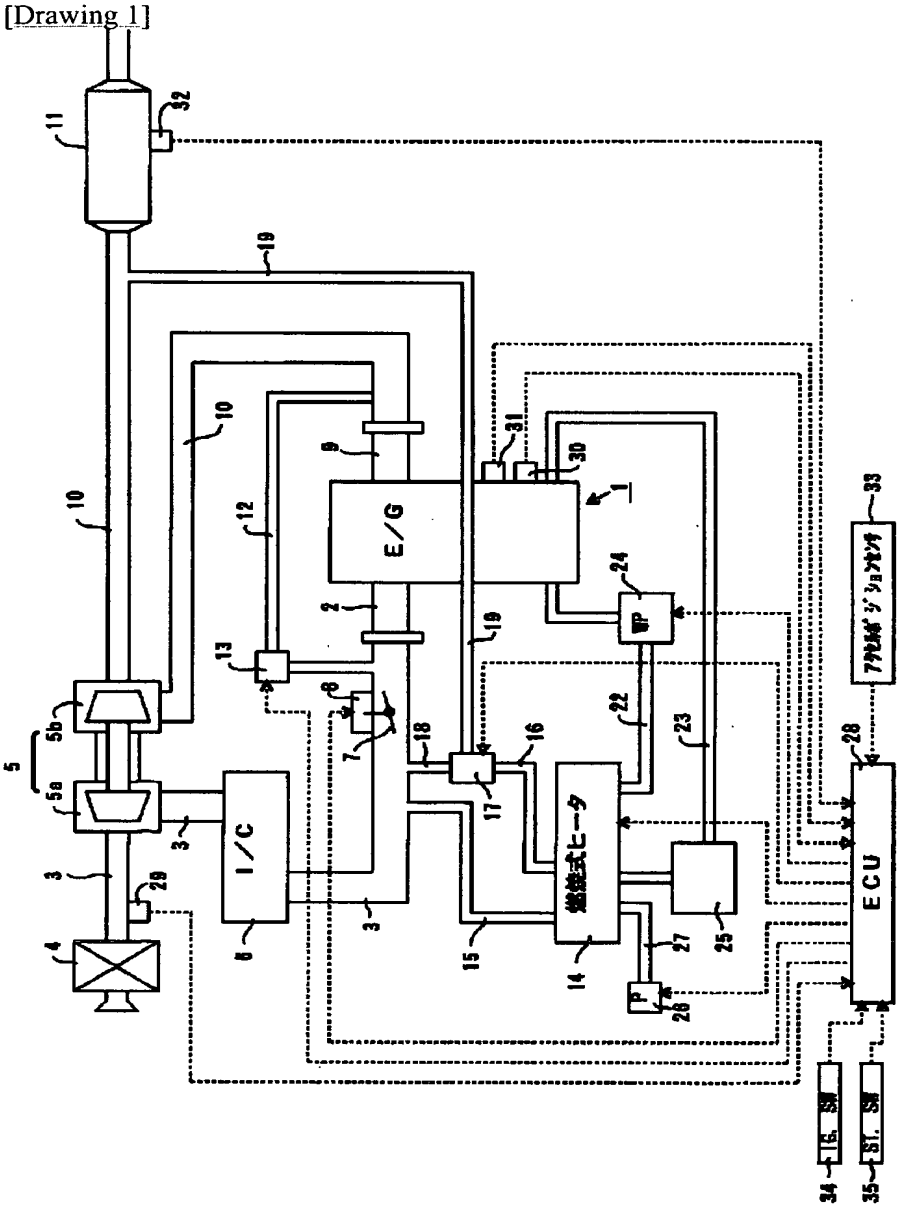
[Translation done.]

* NOTICES *

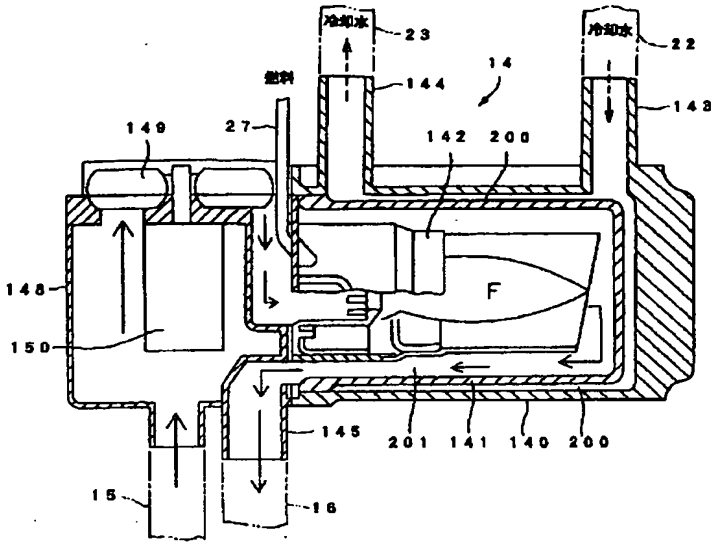
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

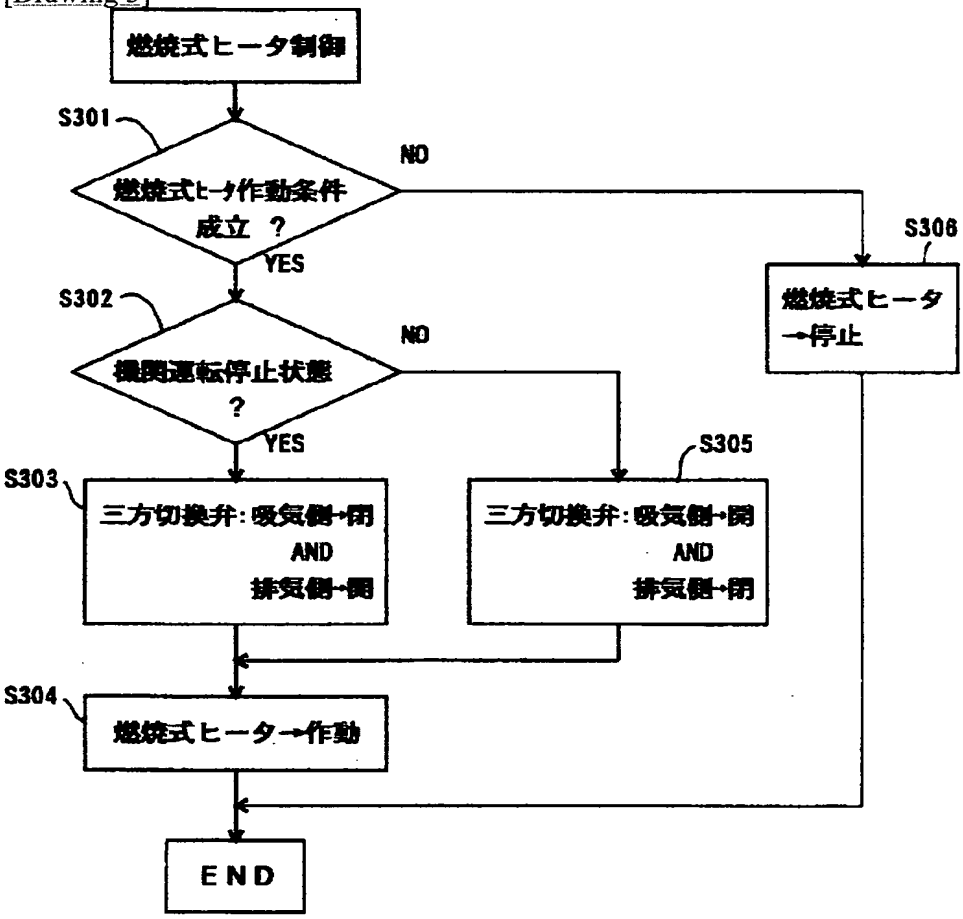
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]

(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: 2002070633 A

(43) Date of publication of application: 08.03.02

(51) Int. Cl F02D 45/00

(21) Application number: 2000268361

(22) Date of filing: 31.08.00

(71) Applicant: DENSO CORP

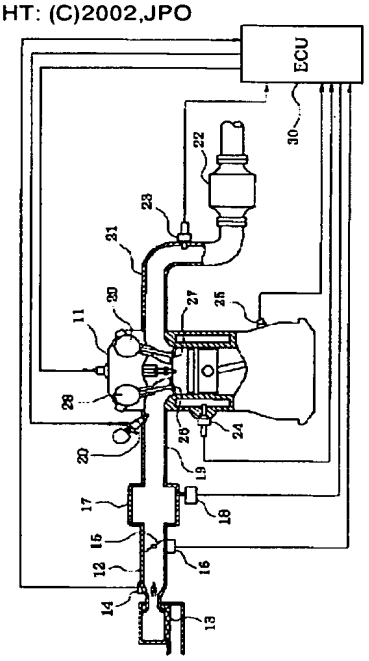
(72) Inventor: NISHIYAMA MASATERU
KAWAI KATSUHIKO

(54) **IN-CYLINDER CHARGING-AIR AMOUNT ESTIMATION DEVICE FOR INTERNAL COMBUSTION ENGINE**

(57) Abstract:

PROBLEM TO BE SOLVED: To estimate an in-cylinder charging-air amount with high accuracy without using charging efficiency.

SOLUTION: In this estimation device, an intake system model for calculating the in-cylinder charging-air amount Me is derived by applying the law of conservation of mass and the state equation of gas to intake air flowing through an intake passage from a throttle valve 15 to an intake port of an engine 11. An intake system model equation is Me=Mth-V/RT.dP/dt, wherein Me is the in-cylinder charging-air amount, V is an inner volume of the intake passage on the downstream of the throttle valve 15, R is the gas constant, T is an intake temperature, and dP/dt is an intake pressure change amount. A deviation (i.e., a pseudo differential value) between a detection value of an intake pressure sensor 18 and an averaging value of the detection value is used as the intake pressure change amount (dP/dt) to eliminate influence of noise (an intake pulsation waveform) superimposed on the detection value of the intake pressure sensor 18.



(19)日本国特許庁（ＪＰ）　(12)**公開特許公報**（Ａ）　(11)特許出願公開番号
特開2002－70633
（P2002－70633A）
(43)公開日　平成14年３月８日(2002.3.8)

(51)Int.Cl.[7]	識別記号	ＦＩ	テーマコード（参考）
Ｆ０２Ｄ　45/00	３６６	Ｆ０２Ｄ　45/00	３６６Ｅ　３Ｇ０８４
			３６６Ｂ
	３５８		３５８Ｃ
			３５８Ｎ
	３６４		３６４Ｄ

審査請求　未請求　請求項の数４　ＯＬ　（全７頁）　最終頁に続く

(21)出願番号　特願2000－268361(P2000－268361)

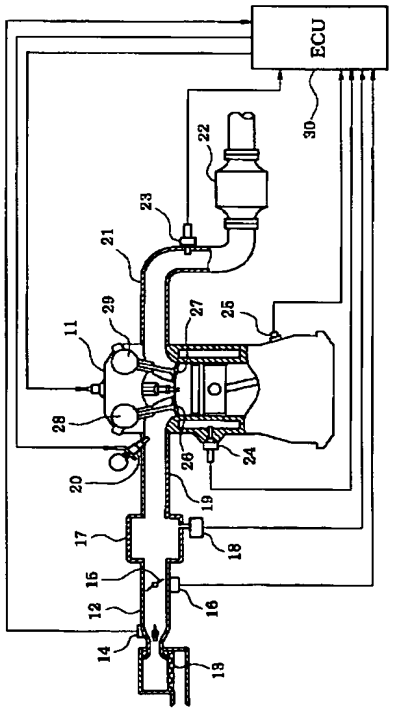
(22)出願日　平成12年８月31日(2000.8.31)

(71)出願人　000004260
株式会社デンソー
愛知県刈谷市昭和町１丁目１番地
(72)発明者　西山　征輝
愛知県刈谷市昭和町１丁目１番地　株式会社デンソー内
(72)発明者　川合　勝彦
愛知県刈谷市昭和町１丁目１番地　株式会社デンソー内
(74)代理人　100098420
弁理士　加古　宗男

最終頁に続く

(54)【発明の名称】　内燃機関の筒内充填空気量推定装置

(57)【要約】
【課題】　充填効率を用いずに筒内充填空気量を精度良く推定できるようにする。
【解決手段】　筒内充填空気量Me を算出する吸気系モデルは、スロットルバルブ１５からエンジン１１の吸気口までの吸気通路を流れる吸入空気に対し、質量保存の法則と気体の状態方程式を適用して導き出したものである。
吸気系モデル式：Me ＝Mth－Ｖ／ＲＴ・ｄＰ／ｄｔ
ここで、Me は筒内充填空気量、Ｖはスロットルバルブ１５下流側の吸気通路の内容積、Ｒは気体定数、Ｔは吸気温度、ｄＰ／ｄｔは吸気圧力変化量である。吸気圧力センサ１８の検出値に重畳するノイズ（吸気脈動波形）の影響を排除するために、吸気圧力変化量（ｄＰ／ｄｔ）として、吸気圧力センサ１８の検出値とその検出値のなまし値との偏差（つまり疑似微分値）を用いる。



1

【特許請求の範囲】

【請求項１】　内燃機関の吸気通路を流れる吸入空気の流量を検出する吸入空気流量検出手段と、

前記吸気通路内の吸気圧力を検出する吸気圧力検出手段と、

スロットルバルブを通過した吸入空気が筒内に流入するまでの吸入空気の挙動を模擬した吸気系モデルを用い、

前記吸入空気流量検出手段で検出した吸入空気流量に基づいて前記吸気系モデル内に流入する空気流量を求めると共に、前記吸気圧力検出手段で検出した吸気圧力の変化量に基づいて該吸気系モデル内の空気質量の変化量を演算し、該吸気系モデル内に流入する空気流量と該吸気系モデル内の空気質量の変化量とから筒内に流入する筒内充填空気量を演算する演算手段とを備え、

前記演算手段は、前記吸気圧力の変化量に基づいて前記＊吸気系モデル内の空気質量の変化量を演算する際に、該吸気圧力の変化量として、前記吸気圧力検出手段の検出値とその検出値のなまし値との偏差を用いることを特徴とする内燃機関の筒内充填空気量推定装置。

2

【請求項２】　前記吸入空気流量検出手段は、熱式エアフロメータであることを特徴とする請求項１に記載の内燃機関の筒内充填空気量推定装置。

【請求項３】　前記吸気系モデルは、前記吸入空気流量検出手段と前記吸気圧力検出手段との応答性の差を補正する調整定数として、前記吸入空気流量検出手段の時定数と前記吸気圧力検出手段の時定数とが組み込まれていることを特徴とする請求項１又は２に記載の内燃機関の筒内充填空気量推定装置。

【請求項４】　前記吸気系モデルの式は、

【数１】

$$Me=\left(\frac{1}{\frac{s}{\alpha 1}+1}\right)Mth-\left(1-\frac{1}{\frac{s}{\alpha 2}+1}\right)\frac{V}{RT}P$$

ここで、　$\frac{1}{\alpha 1}$：吸気圧力検出手段の時定数

$\frac{1}{\alpha 2}$：吸入空気流量検出手段の時定数

Mth：吸気系モデル内に流入する空気流量

P：吸気圧力検出値

V：吸気系モデルの内容積

R：気体定数

T：吸入空気の温度

s：ラプラス演算子

であることを特徴とする請求項３に記載の内燃機関の筒内充填空気量推定装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、吸入空気流量と吸気圧力の両方を検出して筒内充填空気量を推定する内燃機関の筒内充填空気量推定装置に関するものである。

【０００２】

【従来の技術】一般に、筒内充填空気量を推定する方法は、吸入空気流量をエアフロメータで検出して、その検出値から筒内充填空気量を推定する方式（以下「吸入空気流量検出方式」という）と、吸気圧力を吸気圧力センサで検出して、その検出値から筒内充填空気量を推定する方式（以下「吸気圧力検出方式」という）とに大別される。吸入空気流量検出方式は、定常時に吸入空気流量＝筒内充填空気量となるため、定常時の筒内充填空気量の推定精度が良いという利点があるが、過度時には筒内充填空気量の変化が吸気管の上流部に設置されたエアフロメータの出力の変化として現れるまでに暫く時間がかかり、過渡時の応答性が悪いという欠点がある。これに対し、吸気圧力検出方式は、吸入空気流量検出方式と比較して過渡時の応答性が良いという特長がある。筒内充填空気量の変化に伴う圧力変化が吸気圧力センサ付近（サージタンク）まで伝搬する時間は、筒内充填空気量の変化が吸気管上流部のエアフロメータ付近の吸入空気流量を変化させるまでの時間と比較してかなり短いためである。

【０００３】そこで、近年、吸入空気流量検出方式と吸気圧力検出方式の両方式の長所を併せ持つ２センサ併用方式が開発されている。この２センサ併用方式は、エアフロメータと吸気圧力センサの両方を設置して、定常時には、エアフロメータで検出した吸入空気流量から筒内充填空気量を推定し、過渡時には、吸気圧力センサで検出した吸気圧力から次式により筒内充填空気量を演算するようにしている。

【０００４】$Me=\eta\cdot Ne\cdot V\cdot P/(2\cdot R\cdot T)$

ここで、Me：筒内充填空気量

η：充填効率

Ｎｅ：エンジン回転速度
Ｖ：吸気マニホールド内容積
Ｐ：吸気圧力（吸気圧力センサの検出値）
Ｒ：気体定数
Ｔ：吸入空気の温度
この場合、充填効率ηは、エンジン回転速度Ｎｅと吸気圧力Ｐとをパラメータとする二次元マップにより算出される。

【０００５】
【発明が解決しようとする課題】しかし、上記従来の２センサ併用方式では、過渡時の筒内充填空気量Ｍｅ を算出する式に充填効率ηが含まれているため、充填効率ηをエンジン回転速度Ｎｅと吸気圧力Ｐとをパラメータとする二次元マップにより算出する必要がある。このため、充填効率ηを精度良く算出しようとすると、二次元マップ作成のための適合工数が増加したり、この二次元マップを記憶するためにメモリ容量を拡張する必要ある。特に、吸気側／排気側の両方に可変バルブタイミングシステムを搭載したエンジンでは、充填効率ηが吸気／排気バルブタイミングによっても変化するため、充填効率ηをエンジン回転速度Ｎｅと吸気圧力Ｐと吸気／排気バルブタイミングとをパラメータとする４次元マップにより算出する必要があり、４次元マップ作成のための適合工数やメモリ容量が非常に膨大になり、かなりのコストアップになるという欠点がある。

【０００６】しかも、上記従来の２センサ併用方式では、定常時と過渡時で吸入空気流量検出方式と吸気圧力検出方式とを切り換えるため、定常時と過渡時との境界で筒内充填空気量の演算値が不連続となるおそれがあり、それ故に、筒内充填空気量の演算値が不連続とならないように調整する必要がある。

【０００７】本発明はこのような事情を考慮してなされたものであり、従ってその目的は、充填効率を用いずに筒内充填空気量を精度良く推定することができ、適合工数やメモリ容量を大幅に少なくしながら筒内充填空気量の推定精度を向上でき、しかも、定常時と過渡時との境界で筒内充填空気量の演算値を確実に連続させることができる内燃機関の筒内充填空気量推定装置を提供することにある。

【０００８】
【課題を解決するための手段】上記目的を達成するために、本発明の請求項１の内燃機関の筒内充填空気量推定装置は、内燃機関の吸気通路を流れる吸入空気の流量を検出する吸入空気流量検出手段と、吸気圧力を検出する吸気圧力検出手段とを備えたものにおいて、スロットルバルブを通過した吸入空気が筒内に流入するまでの吸入空気の挙動を模擬した吸気系モデルを用い、吸入空気流量検出手段で検出した吸入空気流量に基づいて吸気系モデル内に流入する空気流量を求めると共に、吸気圧力検出手段で検出した吸気圧力の変化量に基づいて該吸気系モデル内の空気質量の変化量を演算し、該吸気系モデル内に流入する空気流量と該吸気系モデル内の空気質量の変化量とから筒内に流入する筒内充填空気量を演算する。これにより、充填効率を用いずに筒内充填空気量を推定することが可能となり、適合工数やメモリ容量を大幅に少なくすることができる。

【０００９】この場合、吸気圧力の変化量に基づいて吸気系モデル内の空気質量の変化量を演算する際に、該吸気圧力の変化量として、吸気圧力検出手段の検出値の時間微分値を用いることが考えられるが、吸気圧力検出手段の検出値にはノイズとなる吸気脈動波形が重畳しているため、吸気圧力検出手段の検出値の時間微分値を用いると、ノイズ波形（吸気脈動波形）の時間微分値を用いることになってしまい、吸気圧力の変化量の演算精度が悪化する。

【００１０】そこで、請求項１では、吸気圧力の変化量に基づいて吸気系モデル内の空気質量の変化量を演算する際に、該吸気圧力の変化量として、吸気圧力検出手段の検出値とその検出値のなまし値との偏差（つまり疑似微分値）を用いる。この疑似微分により、ノイズ成分（吸気脈動波形）の影響をほとんど受けることなく、吸気圧力の変化量を精度良く演算することができ、その結果、筒内充填空気量を精度良く推定することができる。しかも、定常時と過渡時で同じ吸気系モデルを用いて筒内充填空気量を演算するため、定常時と過渡時との境界で筒内充填空気量の演算値を確実に連続させることができる。

【００１１】この場合、請求項２のように、吸入空気流量検出手段として、熱式エアフロメータを用いると良い。熱式エアフロメータは、吸入空気の質量流量に対応した出力を得ることができるので、ベーン式やカルマン渦式のエアフロメータに比べて空気の密度（温度、圧力）による影響がなく、空気の密度による補正が不要であると共に、可動部分が無く、小型（低圧力損失）、低コストである等の利点を有する。

【００１２】しかし、熱式エアフロメータは、吸入空気で冷やされる熱線等の放熱量に応じて出力が変化する構造であるため、吸入空気流量の変化が熱線等の放熱量の変化を引き起こしてそれが出力変化として現れるまでに応答遅れが発生し、この熱式エアフロメータの応答遅れが吸気圧力検出手段の応答遅れよりもかなり大きいため、両者の応答遅れの差が大きくなり、これが筒内充填空気量の演算精度を低下させる原因となる。

【００１３】そこで、請求項３のように、吸気系モデルには、吸入空気流量検出手段と吸気圧力検出手段との応答性の差を補正する調整定数として、吸入空気流量検出手段の時定数と吸気圧力検出手段の時定数とを組み込むようにすると良い。このようにすれば、吸入空気流量検出手段と吸気圧力検出手段との応答性の差を補正することができ、応答性とノイズ除去とを両立させた精度の良

い筒内充填空気量の演算が可能となる。

【００１４】この場合、請求項４のように、吸気系モデルとして次式を用いれば良い。

＊【００１５】

【数２】

＊

$$Me = \left(\frac{1}{\frac{s}{\alpha 1}+1}\right)Mth - \left(1-\frac{1}{\frac{s}{\alpha 2}+1}\right)\frac{V}{RT}P$$

ここで、$\frac{1}{\alpha 1}$：吸気圧力検出手段の時定数

$\frac{1}{\alpha 2}$：吸入空気流量検出手段の時定数

Mth：吸気系モデル内に流入する空気流量

P：吸気圧力検出値

V：吸気系モデルの内容積

R：気体定数

T：吸入空気の温度

s：ラプラス演算子

【００１６】この式は、後述するように、質量保存の法則と気体の状態方程式から導き出されたものである。ここで、吸気系モデル内に流入する空気流量Mthは、スロットルバルブを通過する吸入空気の流量であり、吸入空気流量検出手段は、スロットルバルブよりも上流側で吸入空気流量を検出するため、吸気系モデル内に流入する空気流量Mthは、吸入空気流量検出手段の検出値を位相進み処理することで求められる。上式は、吸気系モデル内に流入する空気流量Mthを吸気圧力検出手段の時定数（１／α１）でなまし処理（一次遅れ処理）すると共に、吸気圧力検出手段の検出値Ｐを吸入空気流量検出手段の時定数（１／α２）でなまし処理することで、吸入空気流量検出手段と吸気圧力検出手段との応答性の差を補正するものである。これにより、充填効率を用いずに、応答性とノイズ除去とを両立させた精度の良い筒内充填空気量Me の演算が可能となる。

【００１７】

【発明の実施の形態】以下、本発明を吸気／排気可変バルブタイミングシステム付きのエンジンに適用した一実施形態を図面に基づいて説明する。

【００１８】まず、図１に基づいてエンジン制御システム全体の概略構成を説明する。内燃機関であるエンジン１１の吸気管１２（吸気通路）の最上流部には、エアクリーナ１３が設けられ、このエアクリーナ１３の下流側には、吸入空気量を検出する熱式エアフロメータ１４（吸入空気流量検出手段）が設けられている。この熱式エアフロメータ１４は、吸入空気の流れの中に配置される熱線（図示せず）と吸気温度センサ（図示せず）が内蔵され、吸入空気で冷やされる熱線の温度と吸気温度との温度差を一定に保つように熱線への供給電流が制御される。これにより、吸入空気流量に応じて変化する熱線の放熱量に応じて熱線への供給電流が変化し、この供給電流に応じた電圧信号が吸入空気流量信号として出力される。この熱式エアフロメータ１４の下流側には、スロットルバルブ１５とスロットル開度を検出するスロットル開度センサ１６とが設けられている。

【００１９】更に、スロットルバルブ１５の下流側には、サージタンク１７が設けられ、このサージタンク１７に、吸気圧力Ｐを検出する吸気圧力センサ１８（吸気圧力検出手段）が設けられている。また、サージタンク１７には、エンジン１１の各気筒に空気を導入する吸気マニホールド１９が設けられ、各気筒の吸気マニホールド１９の吸気ポート近傍に、それぞれ燃料を噴射する燃料噴射弁２０が取り付けられている。エンジン１１の吸気バルブ２５と排気バルブ２６は、それぞれ可変バルブタイミング装置２８，２９によって駆動され、エンジン運転状態に応じて吸気／排気バルブタイミングが調整される。尚、可変バルブタイミング装置２８，２９は、油圧駆動式、電磁駆動式のいずれの方式であっても良い。

【００２０】一方、エンジン１１の排気管２１の途中には、排出ガスを浄化する三元触媒等の触媒２２が設置されている。この触媒２２の上流側には、排出ガスの空燃比（又は酸素濃度）を検出する空燃比センサ（又は酸素センサ）２３が設けられている。また、エンジン１１のシリンダブロックには、冷却水温を検出する冷却水温センサ２４や、エンジン回転速度を検出するクランク角センサ２５が取り付けられている。

【００２１】これら各種のセンサ出力は、エンジン制御回路（以下「ＥＣＵ」と表記する）３０に入力される。このＥＣＵ３０は、マイクロコンピュータを主体として構成され、内蔵されたＲＯＭ（記憶媒体）に記憶された図２の筒内充填空気量演算プログラムを実行すること

で、吸気系モデル式により筒内充填空気量を演算する演算手段としての役割を果たす。

【００２２】この吸気系モデルは、スロットルバルブ１５からエンジン１１の吸気口までの吸気通路（以下「スロットル下流吸気通路」という）を流れる吸入空気の挙動をモデル化したものであり、質量保存の法則と気体の状態方程式から次のようにして導き出される。スロットル下流吸気通路の吸入空気の流れに質量保存の法則を適用すると、次の（１）式で表される関係が得られる。

$$\Delta Min = Mth - Me \quad \cdots\cdots (1)$$

【００２３】ここで、ΔMinはスロットル下流吸気通路内の空気質量の変化量（吸気系モデル内の空気質量の変化量）、Mthはスロットルバルブ通過空気量（吸気系モデル内に流入する空気流量）、Me は筒内充填空気量である。ΔMin、Mth、Me はいずれも単位時間当たり（又はサンプリング間隔）の値である。

【００２４】また、スロットル下流吸気通路に気体の状態方程式を適用すると、次の（２）式で表される関係が得られる。

$$\Delta Min = V/RT \cdot dP/dt \quad \cdots\cdots (2)$$

ここで、Vはスロットル下流吸気通路の内容積（吸気系モデルの内容積）、Rは気体定数、Tは吸入空気の温度（吸気温度）、ｄＰ／ｄｔは単位時間当たり（又はサンプリング間隔）の吸気圧力Ｐの変化量である。

【００２５】上記（１）式と（２）式から次の（３）式が得られる。

$$V/RT \cdot dP/dt = Mth - Me \quad \cdots\cdots (3)$$

従って、筒内充填空気量Me は、上記（３）式を整理して求めた次の（４）式によって算出される。

$$Me = Mth - V/RT \cdot dP/dt \quad \cdots\cdots (4)$$

【００２６】ところで、吸気圧力センサ１８で検出する吸気圧力Ｐには、ノイズとなる吸気脈動波形が重畳しているため、吸気圧力変化量（ｄＰ／ｄｔ）として、吸気圧力センサ１８の検出値の時間微分値を用いると、ノイズ波形（吸気脈動波形）の時間微分値を用いることになってしまい、吸気圧力変化量（ｄＰ／ｄｔ）の精度が悪化する。

【００２７】そこで、本実施形態では、吸気圧力変化量（ｄＰ／ｄｔ）として、吸気圧力センサ１８の検出値とその検出値のなまし値との偏差（つまり疑似微分値）を用いる。

【００２８】吸気圧力変化量（ｄＰ／ｄｔ）＝吸気圧力センサ検出値－検出値のなまし値この疑似微分により、ノイズ成分（吸気脈動波形）の影響をほとんど受けることなく、吸気圧力変化量（ｄＰ／ｄｔ）を精度良く演算することが可能となる。

【００２９】また、熱式エアフロメータ１４は、吸入空気で冷やされる熱線の放熱量に応じて出力が変化する構造であるため、吸入空気流量の変化が熱線の放熱量の変化を引き起こしてそれが出力変化として現れるまでに応答遅れが発生し、この熱式エアフロメータ１４の応答遅れが吸気圧力センサ１８の応答遅れよりもかなり大きいため、両者の応答遅れの差が大きくなり、これが筒内充填空気量Me の演算精度を低下させる原因となる。

【００３０】そこで、吸気系モデル式には、熱式エアフロメータ１４と吸気圧力センサ１８との応答性の差を補正する調整定数として、熱式エアフロメータ１４の時定数（１／α２）と吸気圧力センサ１８の時定数（１／α１）とを組み込む。これにより、次式で表される吸気系モデル式が得られる。

【００３１】

【数３】

$$Me = \underbrace{\left(\frac{1}{\frac{s}{\alpha 1}+1}\right)}_{\text{なまし処理}\ (\text{時定数}=\frac{1}{\alpha 1})} Mth - \underbrace{\left(1-\frac{1}{\frac{s}{\alpha 2}+1}\right)}_{\text{なまし処理}\ (\text{時定数}=\frac{1}{\alpha 2})} \frac{V}{RT} P$$

【００３２】ここで、スロットルバルブ通過空気量Mthは、スロットルバルブ１５を通過する吸入空気の流量であり、熱式エアフロメータ１４は、スロットルバルブ１５よりも上流側で吸入空気流量を検出するため、スロットルバルブ通過空気量Mthは、熱式エアフロメータ１４の検出値を位相進み処理することで求められる。上式は、スロットルバルブ通過空気量Mthを吸気圧力センサ１８の時定数（１／α1）でなまし処理（一次遅れ処理）すると共に、吸気圧力センサ１８の検出値Ｐを熱式エアフロメータ１４の時定数（１／α２）でなまし処理することで、熱式エアフロメータ１４と吸気圧力センサ１８との応答性の差を補正するものである。これにより、充填効率を用いずに、応答性とノイズ除去とを両立させた精度の良い筒内充填空気量Me の演算が可能となる。

【００３３】以上説明した吸気系モデル式を用いて筒内充填空気量を算出する図２の筒内充填空気量演算プログラムは、所定クランク角毎に繰り返し実行される。本プログラムが起動されると、まずステップ１０１で、熱式エアフロメータ１４で検出した吸入空気流量、吸気圧力センサ１８で検出した吸気圧力Ｐ、熱式エアフロメータ１４内の吸気温度センサで検出した吸気温度Ｔを読み込む。この後、ステップ１０２に進み、熱式エアフロメータ１４の検出値（吸入空気流量）を位相進み処理することで、スロットルバルブ通過空気量Mthを求めた後、ステップ１０３に進み、前記吸気系モデル式にスロットルバルブ通過空気量Mth、吸気温度Ｔ、吸気圧力Ｐを代入して、筒内充填空気量Me を算出する。

【００３４】ＥＣＵ３０は、このようにして算出した筒内充填空気量Me とエンジン回転速度に応じてマップ等により基本噴射量を算出し、この基本噴射量に空燃比フィードバック補正係数、水温補正係数等の各種の補正係

数を乗算して最終的な燃料噴射量を求める。

【００３５】図３は、吸気バルブタイミングの進角値が変化した時（過渡時）の筒内充填空気量の演算値の挙動を示している。従来仕様は、充填効率ηを用いて筒内充填空気量を演算する際に、充填効率ηをエンジン回転速度Ｎｅと吸気圧力Ｐとをパラメータとする二次元マップにより算出するため、吸気バルブタイミング進角値の変化による充填効率ηの変化が全く考慮されず、過渡時の筒内充填空気量の演算値が真の値から大きくずれる。従って、従来仕様で筒内充填空気量の演算精度を高めようとすると、充填効率ηをエンジン回転速度Ｎｅと吸気圧力Ｐと吸気バルブタイミング（と排気バルブタイミング）をパラメータとする３次元マップ（４次元マップ）により算出する必要があり、そのマップ作成のための適合工数やメモリ容量が非常に膨大になり、かなりのコストアップになるという欠点がある。

【００３６】これに対し、本実施形態では、吸気系モデル式で筒内充填空気量を演算することで、充填効率ηを用いずに筒内充填空気量を演算する。しかも、吸気系モデル式の変数となる吸気圧力変化量（ｄＰ／ｄｔ）として、吸気圧力センサ１８の検出値とその検出値のなまし値との偏差（つまり疑似微分値）を用い、更に、スロットルバルブ通過空気量Ｍthを吸気圧力センサ１８の時定数（１／α１）でなまし処理（一次遅れ処理）すると共に、吸気圧力センサ１８の検出値Ｐを熱式エアフロメータ１４の時定数（１／α２）でなまし処理することで、熱式エアフロメータ１４と吸気圧力センサ１８との応答性の差を補正する。これにより、本実施形態では、過渡時の筒内充填空気量の演算値と真の値とのずれが極めて小さくなり、過渡時でも、応答性とノイズ除去とを両立させた精度の良い筒内充填空気量の演算が可能となる。しかも、充填効率ηを用いないため、適合工数やメモリ容量を大幅に少なくすることができ、低コスト化の要求も十分に満たすことができる。

【００３７】尚、本発明の適用範囲は、吸気／排気可変バルブタイミングシステム付きのエンジンに限定されず、吸気側（又は排気側）のみを可変バルブタイミングとしたエンジンや、可変バルブタイミングシステムを全く搭載しないエンジンにも適用でき、また、吸気ポート噴射エンジンに限定されず、筒内噴射エンジンにも適用できる。また、エアフロメータ（吸入空気流量検出手段）も熱式エアフロメータに限定されず、例えば、ベーン式やカルマン渦式のエアフロメータを用いても良い。

【図面の簡単な説明】

【図１】本発明の一実施形態を示すエンジン制御システム全体の概略構成図

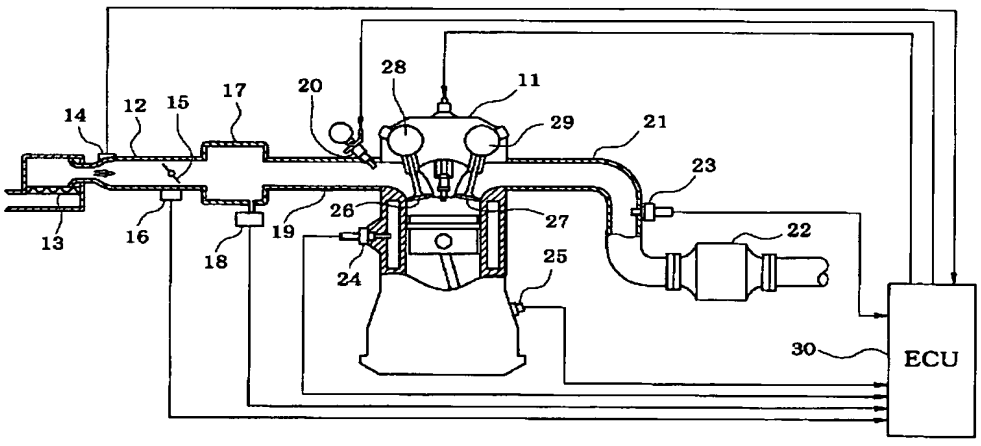
【図２】筒内充填空気量演算プログラムの処理の流れを示すフローチャート

【図３】過渡時の筒内充填空気量の演算値の挙動を説明するタイムチャート

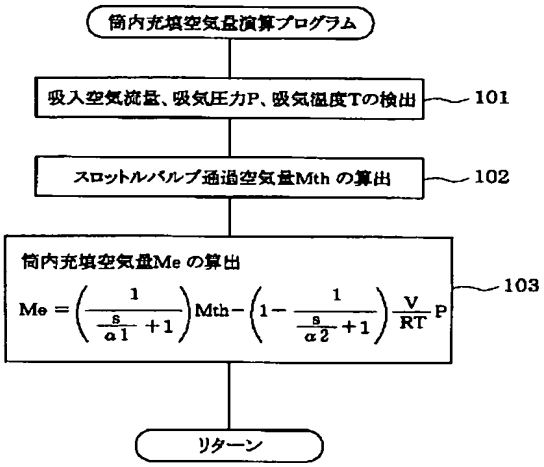
【符号の説明】

１１…エンジン（内燃機関）、１２…吸気管（吸気通路）、１４…熱式エアフローメータ（吸入空気流量検出手段）、１５…スロットルバルブ、１７…サージタンク（吸気通路）、１８…吸気圧力センサ（吸気圧力検出手段）、１９…吸気マニホールド（吸気通路）、２０…燃料噴射弁、２１…排気管、２８，２９…可変バルブタイミング装置、３０…ＥＣＵ（演算手段）。

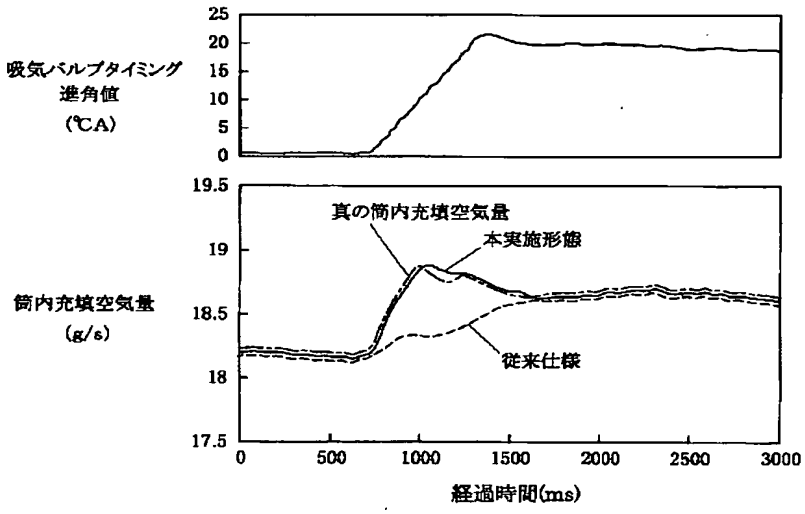
【図１】



【図２】



【図３】



フロントページの続き

(51) Int.Cl.[7]	識別記号	ＦＩ	テーマコード(参考)
Ｆ０２Ｄ　45/00	３７０	Ｆ０２Ｄ　45/00	３７０Ｂ

Ｆターム(参考)　3G084 BA23 DA25 EA01 EA04 EA11
EB08 EB25 EC04 FA02 FA08
FA09 FA10 FA11 FA20 FA29
FA33 FA38